DOE 5480.25 GUIDANCE
September 1, 1993

GUIDANCE FOR AN ACCELERATOR FACILITY SAFETY PROGRAM

This document is an aid to understanding and meeting the requirements of DOE 5480.25, SAFETY OF ACCELERATOR FACILITIES. It does not impose requirements beyond those stated in that Order or any other DOE Order. An accelerator safety program may not need to fully implement all sections of this guidance to satisfy the requirements of DOE 5480.25; a graded approach, based on the complexity and hazard class designation of the accelerator facility, can be used when applying this document.

Table of Contents

SECTION/PAGE

GUIDANCE FOR AN ACCELERATOR FACILITY SAFETY PROGRAM

INTRODUCTION

This is a companion document to DOE 5480.25, SAFETY OF ACCELERATOR FACILITIES, providing programmatic guidance in fulfillment of the obligation of DOE program offices (DOE 5480.25, Paragraph 7a(l)). to do so for their programs. This guidance is provided to promote effective and-consistent implementation of DOE 5480.25 by providing, in most cases, explanations of what is required -and acceptable approaches for meeting the requirements. The guidance is more wide-ranging than the Order itself, however, in that it also addresses selected requirements imposed by other DOE safety orders for which experience has shown guidance is desirable. Note that the reference list does not include all applicable DOE Orders, but only those referenced in this Guidance.

DOE 5480.25 requires the development of certain documentation. Table 1 lists these documents and specifies what organization will have reviewed/approved certain documents; all documents are to be available at the accelerator facility. The Table also reflects review and approval responsibilities assigned in DOE 5480.25; it does not establish additional responsibilities.

The Guidance is divided into two sections dealing broadly with safety analysis and risk acceptance, and with facility operations. The guidance provided is not comprehensive; it focuses on subject material not adequately covered by the DOE Directives System. For example, the means used by accelerator facilities to isolate individuals from harmful operating environments [passive shielding, access barriers, beam interlocks, monitors (stationary and portable), and administrative controls in the order of usual descending preference] are addressed to varying degrees, while no guidance is provided on the important requirement of "As Low as Reasonably Achievable" radiological exposure because it is adequately treated elsewhere.

A graded approach to the application of the guidance provided is essential so "that the depth of detail required and the magnitude of resources expended are commensurate with each facility's programmatic importance and potential environmental, safety, and health impact" (DOE 5480.19). While the guidance provides approaches to satisfactory implementation of DOE safety requirements, other approaches can be used if they can be shown to provide equivalent implementation.

In this Guide, the words "should" and "could" have the following meanings: "should" identifies those methods that have been considered and found by the PSO to be the preferred method for implementing the Order's requirements. The contractor has the option of either following the guidance provided or documenting the technical equivalence of an alternative method. In those cases where a contractor decides to use an alternative method, approach or technique in lieu of the "should" provision, the following actions are required:

- The alternative method is to be documented, with supporting technical basis, analysis, and justification to demonstrate technical equivalency.

- Prior to implementation, the alternative solution and its documented basis shall be approved for use by the most senior line manager in the contractor's organization who has knowledge of, and is responsible for, the day-to-day operation of the accelerator facility.

DOE approval is neither required nor expected for "should" items. The documented justification, including the required approvals, is to be readily retrievable for review and audit by DOE.

The word "could" identifies those elements and suggested methods that have been considered and found by DOE to be discretionary on the part of the contractor. The use of "could" recognizes that there may be site- or facility-specific attributes that warrant special treatment and that use of the preferred method might not provide the desired level of accelerator facility safety program performance. It is not necessary for the contractor to document or otherwise justify the use of alternative methods for "could" items.

A formal determination of whether any specific existing or planned device is within the scope of DOE 5480.25 is a necessary first step prior to applying the guidance contained herein. The device would be excluded under paragraph 4a of that Order if: it is a commercial unit which uses only inherent shielding as supplied by the manufacturer and has not been substantially modified; or is an x-ray generator which complies with ANSI N543 per DOE 5480.4; or it produces radiation incidental to its primary function (such as high voltage power supplies, most video display terminals, and electron beam units used for melting or welding.) The device would be excluded under paragraph 4b of that Order if it cannot produce radiation fields resulting in -an exposure >5 mrem in an hour at a distance of 30 cm from the exterior of the device under maximum operating conditions (where the exterior is understood to mean outside any materials inherent to the construction of the device, but inside any secondary structures large enough for a person to enter, such as a vault, cave, or other shielding enclosure). Where a device is determined not to be within the scope of the Order, the basis for that conclusion needs to be documented.

Table 1:Documentation Required by DOE 5480.25

Document	DOE 5480.25 Paragraph	Disposition
1. Access Control Plan	9b	Available at Facility
2. Shielding Policy	9c(3)	Available at Facility
3. Dosimetry Program Documents	9c(4)	Available at Facility
4. Hazards Surveys	9c(5)	Available at Facility
Shielding/PPS adequacy	9c(6)	Available at Facility
Hazard Classification	9d	Review/Approval by PSO
7. Written Procedures	9f & i	Available at Facility
8. Safety Envelope Exemption for Development Programs	9j	Review/Approval by PSO
9. SAD	10a	Review by OPS/PSO
10. Accelerator Safety Envelope.	10d	Review/Approval by OPS/PSO
11. Experiment Safety Standards/ Exp Safety Review Criteria	10f	Available at Facility
12. Addenda to SAD	10i	Review by OPS/PSO
13. Preliminary SAD (MSA or MP only per DOE 4700.1)	10j	Review by OPS/PSO
14. Accelerator Readiness Review Reports	11d	Review by OPS
15. Modular Commissioning Plan	11e	Review/Approval by OPS
16. System Test Procedures	11f(4)	Available at Facility
17. Personnel Qualification Requirements	12a(2)	Available at Facility
18. Individual Training Records	12a(6)	Available at Facility
19. Internal Safety Rev. System Charter	13a(1)	Available at Facility
20. Actions on Safety Review Recommendations	13b	Available at Facility
21. Implementation Plan	14a	Review/Approval by OPS

ACRONYMS:

OPS - Operations Office & Area/Site Office
PSAD - Preliminary SAD
PSO - Prog. Secretarial Officer
SAD - Safety Assessment Document
PPS - Personnel Protection System
MP - Major Project .
MSA - Major System Acquisition
PO - Program Office

Part I
SAFETY ANALYSIS AND RISK ACCEPTANCE

PART I. A
HAZARD CLASSIFICATION GUIDANCE

INTRODUCTION

DOE 5480.25, paragraph 8b, requires that a hazard class be designated for each accelerator facility using the guidance on classes and their categorization provided in DOE 5481.1B. The function of hazard classification for an activity is to determine who has the responsibility at the highest level for review of the applicable documentation and for approval of the activity prior to undertaking it. These responsibilities are enumerated in the Attachment to DOE 5480.25. In the hazard classification process, the inherent potential of the materials and energy sources present in the activity to harm people or the environment is categorized; as distinct from the actual risk which is much lower after mitigation. As specified in DOE 5481.1B (as amplified by DOE 5480.25), this potential is categorized into one of four classes:

> "Routinely Accepted - the activity only has ordinary or customary hazards of types and magnitudes routinely encountered and accepted by the general public (e.g., cafeteria operations, office space, and machine shops).
>
> "Low Hazard - other than routinely accepted hazards, the activity only has hazards with the potential for no more than minor on-site and negligible off-site impacts to people or the environment.
>
> "Moderate Hazard - the activity has hazards which have the potential for presenting considerable on--site impacts to people or the environment, but at most only minor off-site impacts.
>
> "High Hazard - the activity has hazards with the potential for onsite or off-site impacts to large numbers of people or for major impacts to the environment."

With the issuance of DOE 5480.23, the approach to hazard categorization became bifurcated in DOE. There are now different systems for categorization depending on whether the facility in question is nuclear or non-nuclear. DOE-STD-1027-92 "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE 5480.23, Nuclear Safety Analysis Reports" (issued in December 1992), provides a definitive system for nuclear facilities as well as providing a methodology for establishing which facilities are to be considered nuclear facilities. The hazard classification guidance of DOE 5481.1B now applies only to parts of a facility which do not qualify as a nuclear facility.

2.. GUIDANCE

a. The contractor should employ DOE-STD-1027-92 to establish whether an accelerator facility, or any part of it, must be classified as a nuclear facility. Contractors should take full advantage of the following features of that Standard:

(1) Only the hazard from radioactive materials in the facility are considered. Sealed sources and commercially available products containing radioactive materials can be excluded from the facility's inventory if they meet the conditions stated on page A-1 of the Standard.

(2) The facility may be segmented for the purpose of determining the nuclear hazard category (see page A-1 of Standard). An important qualification is that the hazardous material in one segment could not interact with hazardous materials in other segments. (DOE 5480.25 specifically encourages employing the concept of segmentation, which it refers to as "modules". See, for example, paragraph 10a.) If the facility is determined to be a nuclear facility, the contractor should decide whether the entire facility or only a portion of the facility needs to be classified as a nuclear facility.

The initial application of the criteria of DOE-STD-1027-92 only establishes that a facility is a candidate nuclear facility based on quantity. The final categorization is a determination made by the responsible Program Secretarial Officer (PSO). That determination should take into account the form and dispersibility of the radionuclides present.

b. Any segment of an accelerator facility that is subsequently classified as a nuclear facility must follow DOE's safety requirements for nuclear facilities and should no longer be considered as part of the accelerator facility covered by DOE 5480.25.

C. Those segments of the facility that fall below the hazard category 3 threshold criteria but still possess some radioactive materials are considered by the Standard to be "Radiological- Facilities" which are not subject to the nuclear facility orders. Accelerator facilities (or segments thereof) that are either non-nuclear facilities or Radiological Facilities must be assigned a hazard class using the guidance provided in DOE 5481.1B, considering all sources of hazard, non-nuclear as well as nuclear. The following guidance on the meaning of the modifiers in the DOE 5481.1B criteria is provided:

Major and considerable are defined as that level of hazard at which permanent health effects or environmental damage could occur. (Criteria: injuries that require extensive professional medical attention; > 25 rem effective dose equivalent)

Minor is defined as that level of hazard at which permanent health effects or environmental damage are not expected, but the hazard is of concern and may exceed standards. (Criteria: minor injuries; 1 - 25 rem effective dose equivalent)

Negligible is that level of hazard at which the potential for health effects or environmental damage is very slight. (Criteria: injuries requiring only superficial professional medical attention; < 1 rem effective dose equivalent)

d. If an accelerator is capable of generating a High Radiation Area (which by Chapter 3, Appendix 3B, of the DOE Radiological Controls Manual should have access control) near the target or another loss point, the facility will not be considered "routinely accepted by the public" and will have at least a low hazard classification. A Safety Assessment Document would be required describing at least the access controls and including a shielding analysis.

e. For off-site impact, the potential for radiation exposure to persons off the site is to be considered. For on-site impact, the potential for radiation exposure to individuals outside areas secured (see f., and g. below) by the access system is to be considered.

f. Historically, nuclear facilities have been precluded from taking credit for active mitigative controls required to control the energy source from afterheat or concentrated radioactivity. Accelerator facilities, however, do not have the concentrated activity nor the stored energy of nuclear facilities and are easily turned off if an unsafe condition or event is discovered. While credit is not to be taken for control or mitigation of the hazards by active engineered safety features (radiation controlled interlocks or other electronic beam limiting devices), or for administrative controls that require human intervention after an event starts; because of the inherent characteristics of accelerators:

    (1) Credit should be taken for passive shielding which is an integral part of the facility. DOE 5480.25, paragraph 9c(6), requires the adequacy of the shielding to be verified, and DOE 5480.19 requires configuration controls to be in place. Shielding adequacy should preferably be confirmed by direct measurement; and

(2) Credit should be taken for doors, gates, etc. at access points which have the following controls:

(a) Gates/doors that are locked with strictly controlled keys;
(b) Interlocks on the gates/doors tha t turn the accelerator off or positively prevent beams from entering areas if unauthorized access is made; and
(c) Active warning signs at the access points that provide a warning when the accelerator is operating or is not inhibited from operating by the interlock system.

g. The hazard class of an accelerator facility for a credible potential accident involving prompt radiation outside secured areas and offsite should be determined by:

(1) Assuming the passive shielding remains intact with gates and doors secured;

(2) Assuming the credible "maximal accident" occurs, where the "maximal accident" is that condition which produces, usually at the weakest part of the shielding and at full power, the greatest amount of radiation at the subject position outside the secured area during one hour; and

(3) Comparing the calculated effective dose equivalent to the values in Table 2.

Table 2: Prompt Radiation Effective Dose Equivalent (H) in rem to an Individual Resulting from a Potential Accident

Hazard Class	Off-site	On-Site(Outside Secured Areas)
Low Hazard	Negligible (H < 1)	Minor (I @@ H :@ 25)
Moderate Hazard	Minor (I @i H :@ 25)	Considerable (H > 25)
High Hazard	Major (H > 25)	Major (H > 25)

h. Hazardous chemicals expected to be present should be identified, and their properties and quantities also should be taken into consideration in recommending a hazard class.

3. PROCESS

a. As early as possible in a new program, the contractor should determine whether a safety analysis must be prepared, and if so, how comprehensive the analysis needs to be, and who must approve the resulting safety envelope. To do this, the hazards classification of the accelerator or segment thereof needs to be established as required by DOE 5480.25, paragraphs 8b and 9d.

b. The operating contractor should prepare a summary description of the accelerator (or segment thereof), identifying the hazards and their magnitudes. To determine the hazard class of the activity, the contractor should identify the maximum inventories and energy levels based on system capacities or other upper-bound limits of hazardous chemicals, physical threats to well-being that are not "routinely accepted", radioactivity, and radiation levels. These considerations should be examined against the hazard class definitions of the Attachment to DOE 5480.25 and the modifier definitions given in section 2.c. of this Part in selecting the hazard class to be recommended. This information 'should be submitted to DOE with the recommendation. The limits specified for the activity should be incorporated into the Accelerator Safety Envelope within which the activity is to be conducted.

C. For existing facilities, the Implementation Plan should incorporate a hazard class recommendation, following the guidance provided in this Part, for approval by the Program Secretarial Officer (PSO).

d. The PSO will make known the decision on the hazard classification in accordance with DOE 5480.25, paragraph 7a(2.), as early as possible after receiving the supporting documentation. The decision on a hazard class determines the appropriate approval levels for actions required by DOE 5480.25 (summarized in the Attachment to the Order). The results of this classification effort should be expanded in the safety analysis and addressed by the Accelerator Safety Envelope.

Part 1. B
SAFETY ANALYSIS

DISCUSSION

A safety analysis (1) provides a systematic approach to identifying the hazards of - operation of an accelerator or segment thereof, and/or the experiment program; (2) describes and analyzes the adequacy of the measures taken to eliminate, control, or mitigate identified hazards; and (3) analyzes and evaluates potential deviant conditions and their associated risks. When the results of this safety analysis are documented and coupled with a physical description of the activity so that a knowledgeable, but detached, party-can understand the activity and its residual risks, the result is a Safety Assessment Document (DOE 5480.25, paragraph 10, and Part I.C. of this guidance document). This SAD is the primary information presented to DOE to obtain approval of the proposed activity (see DOE 5480.25, paragraph 11a and 11b). The diagram in Figure I reflects the general process for generating the SAD, conducting an Accelerator Readiness Review, getting the safety envelope a0proved, and beginning operation. This diagram is not intended to provide a time sequence of events. Many of the activities depicted can take place in parallel.

Each experiment needs to be evaluated for its safety and health implications and a safety analysis performed, unless the experiment is clearly included within the bounds of an existing Accelerator Safety Envelope that has already been analyzed and documented in the accelerator facility Safety Assessment Document (SAD) or another experiment's SAD. All experiments could be covered by one SAD, or each experiment could have a separate SAD.

To facilitate changes inherent to An experimental program, the experiments could be grouped, based on their commonalities, so that each set can be governed by a particular safety envelope. Paragraph 10a of DOE 5480.25 requires that each such set of experiments be covered in a SAD which identifies the risks and the mitigative measures associated with those experiments, and provides the justification for the safety envelope selected based on the hazards present. The experiment will need to comply with the requirements imposed by that SAD. With only one Accelerator Safety Envelope, some requirements may be unnecessary for some experiments. With a SAD and a safety envelope for each experiment, effort will be wasted in writing, reviewing, and approving SADs. It would seem desirable for the facility to find the happy medium between these two inappropriate extremes.

Any portion of an accelerator facility that is classified as a nuclear facility in accordance with the classification criteria of DOE .STD-1027-92 must follow DOE's nuclear facility safety requirements, DOE 5480.5. This includes applying the safety analysis requirements of DOE 5480.23. That portion should no longer be considered as part of the accelerator facility covered by DOE 5480.25.

Figure 1: Safety Analysis and Risk Acceptance Process

2. GUIDANCE

a. Staging of the Safety Analysis and Risk Acceptance Process

Because many accelerator projects occur in stages, certain parts may be in use before other major portions-are ready or possibly even before construction has been initiated. To accomplish a timely safety review for the various stages of the project, the safety review and risk acceptance could be accomplished in stages.

The safety analysis for a facility could be divided into segments chosen by the contractor and agreed to by DOE. Additional guidance on facility segmentation is provided on page A-1 of DOE-STD-1027-92. The basic requirement is that all portions of the facility and program be covered by one of the SADs. The division for risk acceptance purposes could probably logically follow the divisions used in the project development or the project management plan generated as per DOE 4700.1. For a simple facility, the SAD for the accelerator and all the experiments could be a single document. For a large facility, the injector may be built an 'operated months or years before the target stations.

In the pre-construction stage of the project, the contractor should propose a conceptual segmentation for the risk assessment process and a schedule for developing the various safety documents, for SAD review, for accelerator readiness reviews, for commissioning, and for initial operation. An initial Accelerator Safety Envelope, involving the beams, energies, and intensities which will guide the facility design, and a hazard classification should be specified for each stage to be reviewed. This information will be reviewed and concurred with by DOE and the proposed hazard classifications agreed to.

b. The safety analysis for an accelerator could evaluate as broad a spectrum of operating modes for the accelerator as is reasonable to establish the parameters or sets of parameters within which the accelerator can be operated safely. It should describe the types of experiments expected to use the accelerator, and analyze the potential safety and health impacts that the experiments present to the accelerator so that an Accelerator Safety Envelope (or Envelopes) can be established within which the accelerator and associated-experiments can be safely operated.- The' accelerator operating organization should have lead responsibility for development of the accelerator Safety Assessment Document. (See Part I.C. of this guidance for information on the structure and content of the Safety Assessment Document.)

C. Paragraph 10a of DOE 5480.25 requires that safety analyses cover all experiments using the accelerator. The analyses should address a spectrum of experiments to be performed, and the consequences of misoperation of the accelerator that might affect the experimental area and apparatus or vice-versa, to establish the parameters within which the experiments can be conducted safely. The research/user organization should have lead responsibility for the experiment Safety Assessment Documents (SAD).

d. Where the experiment program is slowly changing, the separate documents suggested by paragraphs 2.b. and 2.c. immediately above (and by Part I.D, paragraph 2.a. later in this guidance) could be integrated into one SAD without creating the inconveniences that would be brought on by rapidly changing program of experiments. In this case, the accelerator operating organization could be assigned lead responsibility for developing the SAD.

e. A new experiment, or even set of experiments, could be addressed either by creating an appendix to an existing SAD which supports the proposed Accelerator Safety Envelope for that experiment or set of experiments, or by developing a stand-alone SAD.

f. Each Safety Assessment Document should be reviewed at least every 5 years, and revised as necessary so that it reflects current analytical approaches, current DOE safety standards, and a current description of the facility and site.

9. The injectors for a magnetic confinement fusion device are an example of a class of accelerators which likely would have their risks adequately addressed in the safety analysis of another operation and thus, by DOE 5480.25, paragraph 10b, would not require a separate safety analysis.

h. The boundaries of the "accelerator facility" should be carefully described and justified in the SAD so that the training requirements for various persons are clear and undisputable.

PART 1. C

CONTENTS OF SAFETY ASSESSMENT DOCUMENTS

1. DISCUSSION

Accelerator facilities covered by DOE 5480.25 are required to have a current complete set of Safety Assessment Documents which meet the requirements of DOE 5481.1B. The purpose of preparing a Safety Assessment Document (SAD) is to document that the measures taken to minimize the consequences of hazards present in the proposed activity, or to mitigate their consequences, are sufficient to make the risks of the proposed activity acceptable. The amount of descriptive material and analysis that needs to be presented to demonstrate the acceptability will be related to both the complexity of the facility and its assigned hazard class, i.e., a graded approach can be employed.

The guidance below on format and subject matter will facilitate the development of an acceptable SAD meeting the requirements of DOE 5481-1B for accelerator facilities. Other formats which also demonstrate that risks are understood and acceptable will also be acceptable.

A SAD need not address compliance with all applicable DOE Orders, although compliance is expected.

2. GUIDANCE

Chapter 1: Introduction
This chapter should provide a basic understanding of the facility function and the protection afforded the public, Workers (health and safety), and the environment.

Chapter 2: Summary/Conclusions
The summary should provide an overview of the results and conclusions of the analysis contained within the safety assessment. The summary should address the results of Chapter 4 and Chapter 5 of the SAD.

Chapter 3: Site, Facility; and Operations Description

a. This section should describe the accelerator site location and provide specific data for characterizing the site. Any special site requirements or unusual design criteria should be discussed. Limit content to relevant subjects (e.g., if earthquakes are not probable, seismology need not be addressed in detail). The data might include but are not limited to: site geography, seismology, meteorology, hydrology, demography, and adjacent facilities that can impact accelerator operations or be affected by such operations.

b. This section should also describe the accelerator by providing design criteria and as-built characteristics for the accelerator, for its supporting systems, and for components with safety-related functions. This should include a comparison of criteria" assessment to identify and demonstrate conformance with applicable guides, codes, and standards. Deviations from the current DOE design criteria should be assessed for safety implications and documented in this chapter.

C. For new facilities and those to undergo major modifications, a Fire Hazards Analysis with the information specified in paragraph 9a(3) of DOE 5480.7A should be addressed in the SAD or incorporated by reference. See Part I.G. for addressing other fire protection and life safety issues.

d. How the facility fits into the contractor's organization, how safety support services will be provided, how the research and the accelerator operations organization will interface, and matters relevant to responsibility for safe operation should be described.

e. The experiments which will use the accelerator should be described, including those design criteria and characteristics of the experimental equipment, and systems and components, having safety-related functions. This information may need to be supplemented as the experimental program develops.

f. An operations/process description of the accelerator facility should be provided. Both potential accident and normal operation conditions for the machine and the experimental program should be appropriately detailed. Critical operational procedures for normal operation and for potential accident conditions should be identified. Administrative controls provided to prevent or mitigate potential accidents should be discussed.

g. The design process and SAD should consider such worker safety conditions as uncluttered walking/working surfaces and minimizing the use of confined spaces having the potential for chemical exposure. Design features of the facility that ensure chemical and radiation exposures are kept ALARA during maintenance and facility modifications should be delineated.

h. Worker safety controls should be evaluated, such as whether ambient workplace air monitoring is required per the requirements of DOE 5480.11, paragraph 9g(3)(a) and Article 555 of the DOE Radiological Control Manual. Commitments to perform confirmatory surveys should be made as appropriate.

Chapter 4: Safety Analysis

a. This section should document the accident analysis, including any systematic-methodology (i.e., Failure Mode and Effects Analysis, Fault Trees, etc.) used for the identification and mitigation of potential hazards. This section should characterize and quantify hazardous materials, energy sources, and potential sources of environmental pollution at the facility, including radiological hazards. Large quantities of fluids (oils, inert gases,-cryogenic liquids, etc.) are used in some experiment facilities in magnets, counters, and other devices. If the Process Safety Management Rule (29-CFR 1910.119) applies, the SAD should reference the required analyses and summarize their findings. Flammable liquids pose fire and/or even explosion hazards. Cryogenic liquids and inert gases pose cold exposure and oxygen deficiency hazards, respectively. Also, material properties can be drastically different at cryogenic temperatures or changed with temperature cycling. The suitability of materials for their anticipated use should be addressed where this might be a safety or health concern.

b. This section should discuss the methods used at the accelerator facility to control and mitigate the potential hazards. This should include credible challenges to, and the consequences of, the failure of safety systems. Credible maximum bounding accident scenarios for the accelerator and experiments for onsite and off-site effects should be covered. The radiological conditions in different parts of the facility should be identified for potential accident and normal operation conditions. The depth of analysis presented could vary with the magnitudes of the hazards and how readily each can be controlled.

c. The residual risk to the facility, workers, the public, and the environment should be discussed.

Chapter 5: Accelerator Safety Envelope

This section should provide the Accelerator Safety Envelope (further treated in Part I.D.) that will establish and define the limits of operation for the facility/operation. This Envelope will in most instances be more specific than the one-that was prepared to guide the design (see Part I.B, section 2.a.). Paragraph 10d of DOE 5480.25 requires that the basis for the Accelerator Safety Envelope be provided in the SAD. This should be provided in this section or reference made to other portions of the SAD where it is presented. The safety analyses should support the conclusion that the worker, public, and environment will be adequately protected if the subject operations are performed within the boundaries of the Accelerator Safety Envelope.

Chapter 6: Quality Assurance

This section should describe the quality assurance (QA) program to be applied to the accelerator facility and show t ' hat it satisfies the DOE Program Office's Quality Assurance objectives.

Chapter 7: Decommissioning and Decontamination Plan

A description of structural and internal features which would facilitate D & D of the accelerator complex should be provided in this section. Waste management of radiological and hazardous material generation from the D & D operation should be discussed within the context of existing DOE requirements.

Chapter 8: References/Glossary/Abbreviations

PART L D
ACCELERATOR SAFETY ENVELOPE

DISCUSSION

An Accelerator Safety Envelope is a set of physical and administrative conditions based on safety considerations approved by the Department of Energy (DOE 5480.25, paragraphs 7a(3), 7b(3) and 7b(6)) which establish the boundaries within which the accelerator and/or experiments are to be operated in a safe and environmentally sound manner. The basis of the Accelerator Safety Envelope is a safety analysis (DOE 5480.25, paragraph 10), which is a prerequisite for the approval given by the Department to operate an accelerator or undertake a specified set of experiments.

The items specified in the Accelerator Safety Envelope should be easily verifiable by observation, i.e., they are monitorable, countable, or the like.

Implicit in the notion of an Accelerator Safety Envelope is that variations in operating conditions are permitted if and only if they do not exceed the bounds imposed by the Accelerator Safety Envelope. A variation beyond the boundaries of the Accelerator Safety Envelope should be treated as a reportable occurrence, as defined by DOE 5000.3B.

Within its Accelerator Safety Envelope, an accelerator facility can experience unplanned events which interrupt operation but do not compromise the safety of the facility. An unscheduled electrical power outage is an example of such an unplanned happening. The Accelerator Safety Envelope should be specified so that it is not exceeded by the effects of such unscheduled, but anticipated, events of no safety consequence.

Accelerators should be designed to accommodate transient events during normal operation, such as the partial or total loss of the particle beam, without degradation of safety. Such events would not be expected to exceed the Accelerator Safety Envelope. However, such events might cause less efficient operation which could result in remedial actions being taken.

Accelerator operation may routinely take place with wide variability in the parameters characterizing its performance. An "Operations Envelope" can be used to provide assurance that the Accelerator Safety Envelope will not be exceeded as the operating parameters are changed.

2. GUIDANCE

a. Accelerator performance parameters are frequently subject to change as experiments change. In defining an Accelerator Safety Envelope, the ranges or correlations of performance parameters within which the accelerator has been shown to operate safely, the minimum instrumentation and equipment, and the associated administrative controls, all need to be considered. Specific limitations and equipment requirements should be restricted to those needed to ensure safe operation.

b. Categories of items that could be considered for inclusion in the Accelerator Safety Envelope are:

(1) limits on operating variables (such as currents, voltages, energy potentials, beam power, pressures, temperatures, ows needed to preserve physical barriers or to otherwise prevent excessive short-term or long-term risks to persons;

(2) the adopted shielding criteria for different operational modes, and resulting radiological conditions;

(3) requirements related to the calibration, testing, maintenance, or inspection of safety-related systems to ensure their continued reliability;

(4) requirements for protection of the environment (monitoring, release control, and mitigation); and

(5) administrative controls such as minimum staffing levels, qualification, and training for operation, minimum operable equipment, critical records to be kept, currency of procedures, and immediate mitigative actions to be taken if the accelerator safety envelope is exceeded.

C. Where the research mission of the accelerator facility requires frequent reconfiguration, new hardware, new experimental setups and new materials, the careful specification of the Accelerator Safety Envelope is important on one hand to avoid unnecessary delays required to obtain approvals because safety reviews indicate the modification is not covered by the Accelerator Safety Envelope, and on the other hand careful specification is important to avoid the programmatic interruptions and the large expenditure of effort required to investigate and explain why the Accelerator Safety Envelope has been exceeded.

d. The contractor could establish an Operations Envelope within the Accelerator Safety Envelope for each accelerator and each group of experiments. By defining the nominal operating parameters beyond which the operating procedures would require adjustments to be made (and automatic set points could even initiate these adjustments), the Operations Envelope serves to-prevent the Accelerator Safety Envelope from being exceeded.

e. Having different Operations Envelopes for different operating modes of an accelerator would be expected, since the combinations of operating parameters change to carry out different sets of experiments. Variations of operating parameters within the appropriate Operations Envelope of an accelerator are normal. Operation outside an Operations Envelope but still within the Accelerator Safety Envelope should not in and of itself require reporting under DOE 5000.3B. This would be determined by whether it met one of the specific reporting criteria in DOE 5000.3B.

3. EXAMPLES OF ITEMS FOR A SAFETY ENVELOPE

a. The simplicity or the complexity of a safety envelope might be compared to a mailing envelope, which is usually sized to what is being sent. For a simple accelerator operating in a single room, the safety envelope might be only the maximum beam energy and particle current. The safety analysis should then show that for this combination, the shielding reduces the dose rate in all relevant areas to certain values which are judged to be acceptable. If the system operates with several particle types, the impact of the beam which will generate the largest source of radiation exposure should be analyzed. However, the radiation levels from the other beams should be sufficiently analyzed to indicate why they are less serious than the one that was analyzed.

b. Radiation levels from some beams may be low enough that it is acceptable for persons to-be in or adjacent to target enclosures during operation. If operation is proposed while an area is occupied, the safety envelope should identify acceptable combinations of beam type, beam energy, and current or other critical parameters as well as administrative controls which ensure that no unacceptable levels of radiation will be generated while the area is occupied.

c. For a large accelerator, the shielding is often not uniformly I thick. The safety envelope should state the energies of beam and loss intensities allowed in various places. The safety analysis should then show that losses equal to the loss envelope will not cause unacceptable radiation levels anywhere.

d. A target may be radioactive and the beam's energy input might cause it to melt if coolant were lost. Depending on the severity of the potential event, the safety envelope might include requiring water flow under certain beam conditions but not others. For example, water cooling may not be required for low beam power conditions. The safety analysis should show that, for each feasible adverse event, the mitigated impacts have acceptable risk. If the damage to hardware or the spread of radioactivity from melting the target is unacceptable, then providing adequate cooling should be part of the safety envelope.

e. The safety envelope should identify those parameters which ensure acceptable operation when the system is operated within them. The examples above apply to radiation concerns, but other safety concerns need to be similarly bounded in order to constrain operations within the regions shown to be safe and environmentally sound, as required by paragraph 8c of DOE 5480.25.

PART I. E
RISK ACCEPTANCE

DISCUSSION

There are four key elements in the decision process for accepting the risks presented by a proposed activity.

First, the hazards are to be identified. The Safety Assessment Document (SAD) furnishes DOE the information it requires to understand the specific hazards that are present and their magnitudes. The SAD then identifies how the contractor intends to control and mitigate the hazards, and identifies the residual risk of possible mishaps.

Second, the physical and administrative limits and constraints to be placed on the activity to assure safe operation are to be identified in the Accelerator Safety Envelope.

Third, the Accelerator Readiness Review process is used to determine that all involved equipment, procedures, and personnel have been readied.

And fourth, the appropriate organizational level (per DOE 5480.25, paragraph 11) is required to determine that the risks are acceptable and to document the basis for that decision.

Selective guidance is provided here for each of these elements. While the discussion is directed to accelerators, it applies equally to experiments except that many experiments could fall in the "routinely accepted" hazard classification and not require DOE involvement beyond approval of the associated accelerator safety envelope per paragraph 7b(6) of DOE 5480.25.

2. GUIDANCE

a. Review and Acceptance of the Safety Assessment Document and Accelerator Safety Envelope

After contractor development, review, and approval, DOE 5480.25, paragraph 10c, requires the SAD to be submitted to DOE in support of a request for authorization to commission. The SAD could be submitted either as an "approval draft" prior to a formal request ,for authorization to commission, or submitted as "final" along with a formal request for authorization. The proposed Accelerator Safety Envelope should be submitted for DOE review and approval along with the SAD, since the information in the SAD supports the safety bounds selected.

For accelerators with a "low hazard" classification, the Operations Office has the responsibility for directing the DOE review of the document for its adequacy and authorizing the activity, thus accepting the risk. Review by the DOE Headquarters program-office is not mandatory, but may be requested by any part'. For accelerators with a hazard classification of "medium’ or 'high', the DOE HQ program office should appoint a HQ review manager. The DOE Field and Site Offices should always be involved in any review because of their proximity to the accelerator facility and greater familiarity with the details of the proposed operation.

If not done earlier, the PSO should convene during this stage an independent review of the personnel safety and health features of the facility by an ad hoc panel of experts, primarily from other accelerator facilities, as per DOE 5480.25, paragraph 9e, so that the facility can benefit from other state-of-the-art safety information and expertise.

Requests from DOE for clarification or additional information of a substantial nature (i.e., requiring modification of the draft document) should generally be made in writing. Such requests should be directed to the individual within the contractor's organization designated by the contractor, and should come from the DOE official managing the DOE review of the document. The response back from the contractor should go to the requester, but only after being reviewed by the contractor's internal safety review system. When the DOE review manager is with the Headquarters program office, copies of all correspondence should be provided to the DOE Field and Site Offices. Minor requests for information and clarification could be handled verbally in such manner as the contractor's point-of-contact and the DOE review manager agree to.

When an "approval draft" SAD has been submitted and the contractor is notified that DOE is satisfied that the SAD adequately identifies the hazards and finds the precautions described to minimize the resulting risks result in an acceptable residual risk, the final version of the SAD should be prepared and submitted to DOE with the request for approval of that activity. When the intermediate step of an "approval draft" has not been employed, the contractor needs to be aware that the SAD may require revision or amendment before DOE finds it satisfactory to support the request for authorization.

Acceptance by DOE of the risks as analyzed and presented in the SAD is not sufficient to allow authorization of the operation, because it represents how the contractor proposes that things will be done. Whether they are actually as represented needs to be established by a hands-on review (the Accelerator Readiness Review).

b. Accelerator Readiness Reviews

As part of its responsibility to conduct its activities in a safe and environmentally sound manner, the contractor is expected to ensure that all preparations have been-completed and all Accelerator Safety Envelope commitments are being met before-commissioning an accelerator or accelerator segment, undertaking routine operation, or commencing an experiment. The formalization of these efforts for an accelerator is the essence of an Accelerator Readiness Review (ARR). A comparable formality for operating accelerators or experiments is not required by DOE 5480.25, although DOE could always ask for an ARR when the safety circumstances warrant.

Any ARR undertaken by the contractor should be comprehensive in its scope, and the results of the review should be well-documented. The review could be undertaken by a group of well-qualified persons over a short period of time when the accelerator operations group believes they are prepared to undertake the commissioning or routine operation. No ARR group member should have had responsibilities for, or direct involvement in, bringing the accelerator to its present state of readiness. The readiness review group could contain some individuals not associated with the operating contractor to provide a completely objective perspective of readiness for operation.

Instructions to the readiness review group should make it clear what they are being asked to do, namely to determine whether the structures, systems, and equipment identified in the SAD and the Environmental Assessment: are in place; have been fully tested with satisfactory results; are covered as necessary by written procedures that have been reviewed and approved following contractor policies; and will be operated by persons who are fully trained and qualified. The readiness review group should be informed that the review is not intended as yet one more top to bottom safety evaluation, but if they discover any substantial safety issues, these should be raised for management attention.

C. DOE Authorization to Operate

Since a key element in the DOE decision to authorize commissioning activities and routine operation is the Accelerator Readiness Review, the authorizing official should confirm that a thorough ARR has been carried out by the contractor. This is not intended to require duplicating the contractor's efforts, but rather that the DOE review should focus on the adequacy of the contractor's-ARR and its conclusions, with just sufficient sampling on location to provide assurance that items which may have been slighted in-the contractor's ARR report are indeed in good shape. Thus the better the contractor's ARR and report, the less need for on-site DOE presence, and the less time needed for DOE evaluation and authorization.

The basis for DOE's decision to authorize the activity under consideration is required by DOE 5480.25, paragraph 11c, to be written by the authorizing organization. In a summary fashion, this report describes the process used and the effort undertaken by the organization, the factors considered, the reviews conducted, and the facts and safety features considered by the organization to be the most relevant to its decision, and the rationale employed to arrive at its conclusions. Any conditions imposed on the authorization should be explained in the report. Supporting details, when felt to b ' e valuable, should be included only by reference to keep the report succinct and useful as a management tool.

PART 1. F
BEAM INTERLOCK-SAFETY SYSTEM

DISCUSSION

The choice of an appropriate beam interlock safety system affects not only the degree of protection afforded individuals, but also the technical and administrative burden. As required by DOE 5480.25, paragraph 9c(I), the level of protection provided and the system's reliability are to be appropriate for the hazards present in order to avoid having users disregarding the system on one extreme or be negligent in providing for protection of persons at the other extreme. Where the potential consequences are significant, a major design effort including independent reviews, a rigorous program of testing and maintenance, and well-designed and tightly-run administrative controls should be specified. When potential radiation levels would not exceed I rem in an hour (DOE Radiological Control Manual, Appendix 3B), administrative controls such as procedures, warning signs, and barriers are suitable replacements for an interlock system. The interlock system and the administrative controls on it (see Item 2.f. in this Part) should be discussed in the Safety Assessment Document.

2. GUIDANCE

Because the installation and maintenance of an interlock system represents a significant technical and administrative burden, the choice and features of a system should be justified by a careful safety analysis. Given that the features of such a system have been appropriately selected, the following guidance will have applicability for almost any system.

a. Choice of Relay-Based or Computer-Based System

Relay-based logic systems have traditionally been used for accelerator personnel protection, and a large body of experience is available. Computer (or microprocessor) based systems are now widely used in industrial control and have found application in accelerator personnel protection. The guidance in sections b. to f. has been written from a functional point of view, and can apply as well to computer as to relay systems. Important considerations for computer based systems are summarized here.

(1) Computer-based systems are inherently more complex and the failure modes more difficult to analyze than relay based systems. Consequently, it will be more difficult to demonstrate a satisfactory level of reliability.

(2) The following issues should be considered in the selection-of a computer-based protection system.

(a) Software and hardware to be used in the protection system should be validated and verified.

(b) Modularity: Where parts of the protection system need to be decommissioned for servicing or modification, it should be demonstrated that signals from the decommissioned part cannot influence the active portion of the system. Breaking software links is not sufficient, since the part of the system under service is subject to wiring and logic errors. In general, modularity and isolation is more difficult to demonstrate than in relay based systems.

(c) Redundancy: Failure modes are particularly difficult to predict in computer based systems because of their complexity, so backup systems and redundancy are important to reliability. Common cause failures are also difficult to predict because linkages between failures can be subtle. Bugs in logic software are a possible link. If redundancy is provided by independent computer systems, the logic software for the systems might be written by different programmers, working independently.

(d) Isolation and Configuration Control: Computers are often linked through various communication channels, and sometimes these links are subtle, such as connections to a development unit for downloading software, or serial links for machine status information. A computer used for personnel protection interlocks should be dedicated solely to that task, and all external links should be eliminated or rigidly controlled. Configuration control of the software is even more important than for the physical components since software changes are often hard to detect.

(e) Staff Resources: Staff resources should be adequate for both hardware and software aspects during design, construction, operation and maintenance phases.

b. Technical Design

(1) The protective functions of the interlock system should be fail-safe against routine failures, including loss of power or pressure, open circuits, and shorts to ground.

(2) Interlocks should be arranged so that no single failure will cause loss of protection.

(3) System components should be protected from damage, and cable runs outside of cable trays should be armored cable, in conduit, or in flexible conduit. Alternatively, supervised circuits could be used to ensure circuit integrity.

(4) Critical devices are specific accelerator or beam line components that are used to ensure that the accelerator beam is either inhibited or cannot be steered into areas where people are present. Common examples are steering magnets and beam stops or-collimators. Other examples are systems which operate. on the injector or ion source to inhibit the beam.

(a) Two critical devices should be used in an interlock system if a whole-body Very High Radiation Area, as defined in the DOE RadCon Manual, can be produced.

(b) The status of each critical device should be monitored to ensure that the devices are in the "safe" condition when personnel access is allowed. If only one device is used, two separate indication systems should be provided. If the "safe" condition is lost, the beam should be inhibited by operation of other critical devices upstream. Critical device command systems should be independent of the monitoring systems.

(5) Safety devices should not be used as routine shutdown mechanisms, i.e., the design should provide for an orderly means of turning off beams other than activation of an entry interlock before entry is attempted into a controlled access area. The entry interlocks should not constitute the normally used means of disabling beam. However, interlocked safety devices should be employed to maintain beams disabled.

(6) A strict configuration control system should protect .the circuits and functions against unauthorized or inadvertent modification. Critical devices should be clearly labeled to note that tampering is strictly forbidden.

(7) The system could be modular in design so the interlocks for different parts of the facility can be serviced independently. This is particularly important for individual-experimental areas which are often shut down for modification while the rest of the facility is running.

(8) The system design should allow for complete function testing, with the effort and disruption required by such tests kept within reasonable limits.

(9) An independent review of beam interlock system design and the system's testing program should be performed. The findings of that review and the response to the findings should be documented.

C. <u>Personnel Exclusion Areas</u>

(1) Emergency shut-off devices, which are clearly visible, unambiguously labeled, and readily accessible, should be provided in exclusion areas.

(2) Emergency exit mechanisms are required by OSHA standards to be provided at all doors, even when interlocked. Emergency entry features for interlocked doors should not be precluded.

(3) Signs or clearly labeled lights reflecting current exclusion area status should be provided at all entry doors.

(4) Exclusion areas should be searched before the beam is introduced to ensure that no people remain inside. The reliability of the search process should be comparable to the designed reliability of the interlock system.

(a) Search confirmation buttons, or check stations should be placed to ensure that the search team can view all parts of the area.

(b) After an exclusion area is secured, an audible and visual warning should be provided before the beam is introduced.

(c) If entry control is compromised, then the search and the warning interval should be repeated before introducing the beam except under the conditions described in (5) below.

(5) A "Limited Entry" mode could be desirable for larger accelerators (Under this mode, a small number of workers are permitted to enter an already searched area to carry out specific tasks.). Strict controls and well-defined procedures are required for this mode to be acceptable. When the tight administrative controls are maintained during this mode, operation can commence after the-workers have exited without a further search.

d. Testing of Interlocks

(1) The interlock system should be validated at least semi-annually by testing (i.e., validation that the system works as designed under conditions of use). An interlock system should not be used to provide protection unless a complete functional test has been done within the specified testing frequency. A short grace period could be allowed if specified in the administrative procedures. A successful testing program will depend on a system design which accommodates testing and the commitment of machine time and resources to accomplish the tests.

(2) Written test procedures having sufficient detail to ensure a complete functional test of the interlock system should be used. Testing should be executed with a check sheet with a check-off for each observed response, thus providing an auditable record.

(a) The functional test of the interlock system should exercise the system inputs and verify each protective response.

(b) Integrity of redundant interlock chains should be determined.

(C) It is important that critical devices be tested in their operating configuration, and at least once during the test the system should be exercised from end to end. For example, verify that opening an entry door causes the expected end result (e.g., a pulsing linac modulator turns off, not just that a relay drops out or a power supply ready light turns off).

(d) Testing should also verify that the system provides protection in response to likely improper actions.

(3) A functional test should also be completed after modification or maintenance work is done on an interlock system. Those maintenance and service actions which are deemed to be trivial and which do not require functional testing could be identified and justified generically or individually..

e. Documentation of the Interlock System

The following documentation should be prepared and maintained:

(1) a written functional description of the interlock system;

(2) the physical and electrical configuration of the system;

(3) a description of the document control and review system for keeping documentation complete, accurate, and current;

(4) an auditable record of interlock system test results; and

(5) management approval of the system as described.

f. Administrative Controls on the Beam Interlock System

(1) There should be a well defined and rigidly enforced configuration control process that provides a mechanism for the review and approval of changes in system design and of modifications of function and logic. The detail of the review and the level of approval could be commensurate with the degree of hazard involved.

(2) A notable example of modification of function is the bypassing of an interlock. This should be permitted only if equivalent safety is provided, either by procedures or by alternate equipment. The proposed bypassing needs proper review and approval, and the interlock system should be tested with the bypass in place, and again after it has been removed.

(3) There should be a clear definition of the procedures and restrictions on interlock maintenance work, such as:

(a) the work should be done only by authorized persons;

(b) proper safeguards, e.g. a locked beam stop, should be required before the interlock is taken out of service. The safeguard should be independent from the system being worked on; and

(c) the system should be returned to service only after a suitable test has been done.

PART I. G

FIRE PROTECTION AND LIFE SAFETY

DISCUSSION

Although the Accelerator Safety Order does not have specific fire protection and life safety requirements, this guidance is being provided as one approach for the assessment of the risk associated with potential fire and the inclusion of adequate mitigative features included in the design. and operation of an accelerator facility.

The DOE Fire Protection Order, DOE 5480.7A, requires compliance with the National Fire Protection Association's "Life Safety Code" (NFPA Standard 101) for safety to life from fire in DOE facilities. This guidance will not restate those requirements; it will instead provide a logical method for the analysis of the fire hazard in an accelerator enclosure to provide equivalent means for complying with the Life Safety Code's prescriptive requirements.

2. GUIDANCE

a. Basic Emergency Egress Reguirements

The Life Safety Code allows a range of travel distances to an exit, depending on how the occupancy of the facility is defined. Given the qualitative nature and the inherent uncertainties of occupancy classification, the use of a hazard analysis could provide the best basis for assessment of fire risk and life safety.

b. Property Protection Issues

In addition to the life safety requirements, DOE 5480.7A establishes fire suppression requirements for types of environments exceeding certain specified conditions. Again, a hazard analysis could be used to provide a more precise fire risk assessment.

C. Analytical Methodology

Analytical methods could be used to establish a basis for safe travel distances to exits. One method is described here, although there are many others which could be employed.

(1) Design Basis Fire

Establish the parameters of the fire against which the occupants are to be protected (i.e.., the Design Basis Fire (DBF). The potential fuels (fixed and transient) in the accelerator enclosure should be identified, along with their combustibility parameters. The basic parameters required to predict the DBF from these fuels include: the chemical heat content; the physical form; quantity; characterization of the fuel as a "package," the whole amount of which is likely to be involved in the fire; the identity of the worst case fire among the possible fuel packages; and the energy release rate over time to be expected from the fuel package, with supporting rationale, e.g. test data. Pertinent parameters of the accelerator enclosure are also used in establishing the DBF. These include the heat transfer parameters of the walls, ceilings, and floors; ventilation; and the physical dimensions of the accelerator enclosures.

(2) Use of Computer Models

The complexity of calculating fire effects lends itself to the use of computer fire models. The model used should be applicable to the specific situation (most often a ventilated tunnel).

(3) Decision Parameters

The data produced by the model should be sufficient to show where and when conditions untenable to human life develop. Typical hazards are loss of visibility, presence of toxic products above acceptable thresholds, or temperature above tolerable thresholds. Limits for these are readily available in the literature. This establishes the "available safe egress time."

The designer then determines the time required for safe egress from the accelerator enclosure, i.e. the "required safe egress time." This can be done by using anthropometric data on human walking speeds, human endurance, and the initial design for the distance between exits. Again, models could be employed.

If the time required for egress exceeds the time available, the designer revises the mitigative features used in the analysis, such as fire suppression systems, nonflammable materials, fire detection systems, ventilation, or travel distance to exits, and re-runs the model to see if the revised design will provide more safe egress time than is required. Some factor of safety should be employed to allow for the estimated uncertainties in the calculations.

(4) Property Damage Considerations

In addition to life safety considerations, the designer analyzes the susceptibility of the-equipment in the accelerator enclosure to damage from fire and fire products. If the effects of the DBF would cause unacceptable damage to equipment within the accelerator enclosure, mitigative features such as automatic fire suppression systems should be installed.

(5) Other Life Safety Considerations

The possibility of leaks of cryogenic, toxic, or flammable liquids or gases, which may pose asphyxiation, fire, or explosion risks, are also considered in the design of the egress provisions. A leak of cryogenic fluids might displace the oxygen in the accelerator enclosure such that the ventilation and travel distance to an exit would not be sufficient to allow safe egress.

The density of the fluid involved in an incident affects the nature of the hazard greatly. Gases such as helium will travel horizontally along the ceiling of the accelerator enclosure until a vertical opening is reached, where they will follow that upward to perhaps a service building and potentially create an oxygen deficiency hazard (ODH). Gases which are denser than the ambient air, such as liquid argon or liquid nitrogen, will follow the floor of the accelerator enclosure until they reach a lower area, where they will accumulate and create an ODH condition. Provisions for egress should account for these conditions..

(6) Configuration Control

The success of the mitigative features depends on their being maintained as originally intended. If administrative controls are used, the management should commit to having strict materials controls for the life of the facility. Engineering controls must be maintained in a state of readiness.

(7) Deviation from DOE 5480.7A

Deviation from the specific provisions of DOE 5480.7A requires an exemption as specified in that Order. If a deviation from a standard referenced by DOE 5480.7A is proposed, and equivalency to the standard is demonstrated, the Operations Office Manager (unless otherwise designated by a PSO) can approve this as the Authority Having Jurisdiction.

Part II
FACILITY OPERATION

PART 11. A
OPERATIONS

1. DISCUSSION

Accelerator operation may require a high degree of flexibility for the effective execution of experiment programs and/or research and developmental activities; but these activities also must always be conducted in a safe and environmentally sound manner. Specific guidelines and appropriate procedures for accelerator operation and for conducting experiments will ensure that a high level of performance is achieved in a safe and environmentally sound manner, and in accordance with applicable rules and regulations.

The General Introduction to DOE 5480.19's "Guidelines for the Conduct of Operations at DOE Facilities" recognizes that facilities can use approaches or methods different than those identified in the guidelines as long as the intent of the guidelines is met. Since the subject categories in those Guidelines are of varying significance to accelerators, the guidance that follows regroups the material-in Attachment I of DOE 5480.19 to make the subject categories more relevant to accelerator facilities. There is one exception: Chapter V of DOE 5480.19, Attachment 1, is addressed by Part II.E, "Training and Qualification," of this Guidance.

2. DOE 5480.19 GUIDANCE

To meet the intent of DOE 5480.19, DOE accelerator facilities could issue facility'-specific "Guidelines for the Conduct of Operations", addressing the areas outlined in the following paragraphs.

a. Operations Organization and Administration

Procedures or other definitive documentation should describe lines of authority and responsibilities for the safe execution of program goals, availability of resources and interfaces to other groups, relationships to safety organizations, operations performance monitoring guidelines, accountability, training policies, and safety planning policies. Applicable guidance is in Chapter I of Attachment I to DOE 5480.19.

b. Shift Routines and Operating Practices

Standards for the conduct of work practices for operations staff should be established. These standards should address adherence to operating procedures and equipment specifications, status awareness and response practices of operations staff, emergency response requirements, as well as logkeeping and reporting requirements. Chapter II of DOE 5480.19, Attachment I, contains applicable guidance.

C. Control Room Activities

Guidelines for maintaining a professional atmosphere in control centers of the facility should be established, commensurate with the importance of the control room as an operating base and coordination center for important facility activities. Policy regarding authorization for, and supervision of, the operation of equipment should be specified, both for routine shift operation and for research and development activities conducted from the main control room. DOE 5480.25, paragraphs 9f and 9g address control room operations. Chapter III of DOE 5480.19, Attachment I, provides applicable guidance.

d. Communications Systems

Guidelines covering the correct use of communications systems including radios, telephones, public address and paging systems should be issued. This should include emergency communications and the announcement of changes in operating conditions. Chapter IV of DOE 5480.19, Attachment I provides applicable guidance.

e. Operations

Operations procedures should be established to provide specific direction, where appropriate, for operating processes, systems, and equipment during normal, deviant, and emergency situations. These operating procedures should be designed to ensure that the Accelerator Safety Envelope is not breached (DOE 5480.25, paragraph 8d), and that facility operations remains within the Operations Envelope if this concept is employed (see Part I.D. of this Guidance document). Other methods of disseminating operations information and keeping operators current with changes should also be addressed. Chapters X, XI, XIV, XV, XVI, and XVII of DOE 5480.19, Attachment I, should be referred to for guidance.

f. Conduct of Research and Development

Guidelines should be established to ensure that research and development programs on the accelerator facility are conducted consistent with all facility safety requirements. The guidelines should ensure appropriate safety controls for access of accelerator specialists and experimenters to the facility equipment for the purpose of research, development and experimentation. Chapters XIII and XIV of DOE 5480.19, Attachment I, should be referred to for applicable guidance. (See also items b. and c. of this Part).

g. Status Control of Equipment & Systems

Procedures should be established to ensure that: the facility configuration is maintained in accordance with design requirements that status changes are properly authorized; and operating staff are aware of the status of the equipment and systems; Lock and tag procedures, guidelines for status verification, guidelines for logkeeping and documentation of equipment status, and requirements for shift turnover information should be addressed in this context. Chapters VIII, IX, XI, and XII of DOE 5489.19, Attachment I, contain applicable guidance,

There should be an administrative control system established to ensure that equipment and components are properly labeled. Refer to Chapter XVIII of DOE 5480.19, Attachment I, for applicable guidance.

PART 11. B
INTERNAL SAFETY REVIEW

DISCUSSION

The basic motivation for the requirements specified in DOE 5480.25, Paragraph 13, is that the contractor should take full responsibility for. the safe, healthful, and environmentally sound operation of the accelerator facility. The internal safety review system must provide the objectivity necessary to give contractor management reasonable-assurance that ES&H issues are not being overlooked, ignored, or given inappropriate priority.

In particular, environmental, safety, and health (ES&H) appraisals, assessments, and other evaluations by DOE and other Federal and state regulatory agencies should not be viewed by the contractor as substituting for its own efforts. ES&H appraisals by external organizations do not relieve the contractor of the responsibility to conduct adequate safety surveillance and review of its activities.

The paragraphs referred to in the following guidance are from DOE 5480.25.

2. GUIDANCE

a. The objectivity and independence called for in paragraphs 13a(5) and (6), should be achieved by using individuals who are not directly involved with the activity being reviewed.

b. While the system is intended to be internal to the contractor's organization, independent technical competence in all areas required for an appropriate review may not be readily available within the organization. Consultants from other DOE accelerator facilities could be used, and might be used as a regular complement to internal .staff to provide an additional degree of objectivity and independence as well as nurturing experience within the DOE system.

C. A review should not be conducted in isolation from the activity being reviewed. That is, interaction with representatives of that activity should be encouraged as long as the conclusions of the review can be formed free of the pressures, constraints, and unchallenged assumptions of the program under review.

d. An internal review should objectively cover the items listed in paragraph 13a(5) and in particular should endeavor to identify any items that may be Unreviewed Safety Issues and determine whether' they in fact are. The scope of the review and any advice offered are required to be documented.

e. Since the system is advisory to program management (paragraph 13a(2)), the manager receiving the advice should be free to act on the advice as the manager deems appropriate.

f. The disposition of all advice received needs to be documented (Paragraph 13b). This should cover both the directions given to program staff to take action, and, separately, the reasons for altering or rejecting advice.

g. The actions taken by program staff on all directions received from management which derive from advice provided by the internal review system are required by paragraph 13b of DOE 5480.25 to be documented. A written communication to the manager who received the advice from the review system and directed that action be taken, could serve to close the action loop.

PART II.
EXPERIMENT SAFETY

DISCUSSION

Each experiment needs to be evaluated for its safety and health implications, and a safety analysis performed if it cannot be shown that the experiment clearly falls within -bounds that have already been analyzed and documented in another Safety Assessment Document (SAD).

2. GUIDANCE

a. DOE 5480.25, Paragraph 10g, requires that the safety implications of each experiment or set of experiments be addressed in a SAD. The experimental activities may, in some cases, be adequately covered by a SAD written for an accelerator facility as a whole. In most cases this will not be the best way to address experiment safety. A separate SAD addressing the experimental program will usually be more expeditious. To the extent practicable, the safety 'analysis of experimental work could address sets of experiments and establish the bounding conditions within which each particular set of experiments-can be conducted in a safe and environmentally sound manner.

b. For each set of experiments, the safety analysis should identify the safety training needs, including who needs training, and the nature, content, and frequency of the training beyond the general safety orientation provided to all experimenters.

C. The scope and content of written and approved safety procedures for experiments should be appropriate to the safety, health, and/or environmental impacts the experiments present. DOE 5480.19, Attachment I, Chapter XVI, "Operations Procedures" can be used for more specific guidance on experimental activities by making appropriate translations of the terms "facility", "operations", and operator.

d. For each experiment, a written assessment of the safety and health implications should be made as early as possible in the design of that experiment. The experiment should be briefly described and the hazards to be introduced should be identified. The assessment should consider whether additional training and/or controls are required to perform the new experiment if it can be reasonably considered as part of an existing set of experiments.

e. This assessment should be reviewed following the protocol identified in part II.B. The contractor can authorize the initiation of the experiment if the assessment concludes that: the experiment falls completely within the bounds of a previously analyzed, documented, and approved set of experiments; the experiment's environmental, safety, and health characteristics are adequately controlled by the existing Accelerator Safety Envelope; and the contractor's independent internal review supports these conclusions. Where these conditions are not met, a safety analysis will be needed to support a request for DOE approval of the experiment.

f. Copies of operating safety procedures for experimental activities should be available to all individuals involved in those aspects of the experiment.

g. During the operational phase for most experiments, particularly complex or long lasting ones, periodic audits should be conducted with a frequency no less than annually to verify that no changes to. the safety and health conditions analyzed in the Safety Assessment Document have occurred.

h. To avoid inadvertently exceeding the Accelerator Safety Envelope, a system should be employed that identifies which experimental apparatus, monitoring systems, and procedures cannot be changed without prior approval, and who can approve. DOE 5480.19, Attachment 1, Chapter VIII can be used for more specific guidance.

PART II. D
ACCESS CONTROL

1. Discussion

The requirement in DOE 5480.25, paragraph 9b, for a plan to control access to the accelerator facility is predicated on the need to protect the U.S. Government from unnecessary liability due to actual or alleged injury of casual visitors, including trespassers; to protect property from damage or theft; and to provide reasonable assurance that all persons at the accelerator facility are either aware of the potential hazards and the emergency procedures, or are under the guidance of someone who is fully aware of these matters.

2. Guidance

a. As part of the plan for control of access, specific consideration should be given to the question of unsupervised occupancy by persons who are not employees of the contractor or the DOE. These individuals should be understood to be included in the requirements on access contained in DOE 5480.25, paragraph 9c(2).

b. Implementation of a two-person safety rule for selected areas of the facility should also be considered.

C. Remote mechanisms for access control could be considered [e.g., such as personnel recognition devices, closed circuit television, motion detectors, etc.] for positive assurance appropriate to the consequences of vulnerability to advertent or inadvertent violation of the established personnel control system.

PART IL E

TRAINING AND QUALIFICATION

1. DISCUSSION

DOE 5480.25, paragraph 12, DOE 5480.11, and the DOE Radiological Control Manual require that all persons assigned to, or using, an accelerator facility be given a general safety orientation appropriate to their circumstances, and that certain categories of individuals receive more detailed training. The objective of this safety orientation and training is to ensure that all individuals have the knowledge needed to perform their duties in a manner which does not unduly place them or others at risk for injury or illness.

2. GUIDANCE

a. Training Program Content

(1) A complete training program for persons associated with an accelerator facility should-include general safety training, facility-specific safety training (the accelerator facility's safety rules and procedures), task-specific training (the knowledge and skills required to perform specific tasks), a system for recording training results, and a mechanism for formally confirming that an individual has been judged qualified to perform the duties that were the objective of the training.

(2) For each position, including experimenters requiring unescorted access, a matrix should be developed to indicate the specific training program elements needed including specific courses and retraining intervals. The training program should be able to bring persons with entry-level knowledge and skills to the desired proficiency.

(3) Some trainees may have knowledge and skills that make part of the training superfluous, so they could be excepted from those training elements. The basis for granting an exception should be documented. The confirmation process should be the same as for persons who were not excepted from any part of that training. In particular, DOE 5480.25, paragraph 12a(3), requires that proficiency tests be given in all cases.

(4) For those jobs where medical requirements are applicable for performing the various tasks, the criteria should be established and used as a factor in determining that an individual can be confirmed for that job.

(5) The time requirements and conditions for retraining and reconfirmation should be delineated by the operating organization with the agreement of contractor senior management. These requirements should cover acceptable periods of inactivity brought on by extended absences of individuals and by seasonal schedules for accelerator operation or experimental activity.

(6) For each training element, an auditable system of records documenting training content and results should be established to demonstrate achievement of the training goals. Records to be retained could include:

- course syllabus
- instructor's handbook (where applicable)
- handouts provided to trainees
- copies of written examinations with dates given, answers expected, and results
- attendance sheets

(7) Individual training records should include:

- education, relevant experience, and as required most current health evaluation
- most recent graded written examinations in each t raining element
- written critiques of task performance during training, including tasks observed, questions asked by the evaluator, and overall conclusion of the evaluator
- summary of training attendance, training completed, proficiency demonstrated, and other information used as the basis for judging whether the individual was qualified for confirmation
- copies 'of acknowledgment of qualification
- documentation of the basis for granting an exception to a training element

b. General Safety Orientation

(1) The operating contractor-is assumed to have a general orientation program in place addressing the contractor's policies and procedures for fire protection, health protection, radiation protection, occupational safety and health, security requirements, etc. which addresses the-DOE 5480.11, paragraph 9o(I), Occupational Worker training requirements.

(2) The contractor's broad orientation program will almost certainly need to be supplemented by a safety orientation providing general awareness of safety as it relates to the accelerator facility. All persons assigned to or using the facility are required to take selected elements of this orientation appropriate to their needs. The material covered in the orientation could include:

- facility first aid capability facility hazards awareness
- emergency notification
- OSHA orientation
- facility safety characteristics
- radiation safety practices
- occurrence reporting practice

(3) DOE 5480.25, paragraph 9c(2), and DOE 5480.11, paragraph 9o(l), require all persons who have not received general safety orientation appropriate to their needs at the facility to be escorted. The person responsible for escorting such an individual should be knowledgeable of the hazards likely to be encountered, applicable facility policies and procedures, and appropriate emergency responses.

c. Facility-Specific Safety Training

Courses in this category, including Radiation Worker training required by DOE 5480.11, paragraph 9o(2), are intended to provide detailed information about local work hazards and their control, and to convey knowledge of safe operating procedures and practices as employed at the facility. The material covered in these courses could include:

- self-contained breathing apparatus
- controlled entry areas
- hazardous waste generator rules
- radiation safety/practice
- facility emergency procedures
- respirator use
- confined space locations and rules
- lock and tag process
- control of activated material
- other hazards, their locations, and management

d. <u>Task-Specific Training</u>

(1) Task-focused training is intended to enhance an individual's performance of operational tasks and to ensure that an individual has the skills necessary to keep the accelerator or its subsystems operating within the Accelerator Safety Envelope in a useful and productive manner.

(2) Typically, this training is received within the job environment and with as much hands-on training as possible. The instruction should be controlled by the individual's immediate organization because the operation of equipment is usually involved and-the equipment may be "one of a kind" with only a few trained operators. (See DOE 5480.19, Attachment I, Chapter V for additional guidance.)

(3) Proficiency evaluation should be specified for equipment or systems which if improperly operated or maintained present a potential hazard to human health or safety. The trainee should be permitted to develop and demonstrate proficiency by completing the procedures while under the direction of a fully qualified operator.

(4) Specific skills that could require a combination of class room and hands-on experience include:

- hoisting and rigging

- particle beam control

- forklift operation
- cryogenics handling
- high voltage safety
- compressed gas handling

e. Maintenance and Other Support Staff

The safety-related training requirements for the various maintenance and support staff will be determined by the types of activities they will be called upon to perform, the nature of the hazards they may encounter, the degree of direct supervision required, and the understanding required of the accelerator facility components to be worked on.

f. Experimenters

(1) As required by DOE 5480.25, paragraph 12d, experimenters are to demonstrate appropriate knowledge of the hazards of the systems they are involved with, and how associated risks are minimized. This could be addressed by developing and implementing a separate detailed training program for experimenters.

(2) Experimenters should be granted authority to operate or otherwise use experimental apparatus only after they have demonstrated the skills and understanding deemed appropriate in accordance with the training plan. In those cases, where the hazards are routine, the plan could require only general safety orientation training for unescorted access.

g. Visitors

(1) Any person at the facility, whether an employee of the operating contractor or not, who is not permanently assigned to the facility, or who is not a long-term user of the accelerator's beams for research purposes, should be considered a visitor to the facility.

(2) Visitors can gain unescorted access to the facility only after receiving appropriate general-safety orientation (as outlined in 2.b. above) and any relevant facility-specific safety training deemed to be necessary to permit them to safely accomplish their mission at the facility. These requirements should be established by facility management.

(3) Even when visitors are to be escorted, an orientation should be used to familiarize them with the facility's hazards and the emergency plan as it relates to them (see DOE 5480.11).

PART II. F
RADIATION SAFETY

IONIZING RADIATION

The primary standard for occupational radiation protection is DOE 5480.11, and the DOE Radiological Control Manual (RCM). This section will deal with program features somewhat unique to accelerators.

a. Radiation Dosimetry

(1) Discussion

The prompt (generated instantaneously by the beam) radiation environments at particle accelerators range from negligible at low-energy heavy-ion accelerators to extremely high intensity at high energy, high intensity units. The radiation exposure fields differ from those usually found at reactors or nuclear facilities in that they often extend to higher energies and result from cascade phenomena, and therefore typically consist of several types of ionizing radiation distributed over a broad range of energies. In addition, the radiation fields often have a complex time structure, which depends on the accelerator repetition rate, the details of the radio-frequency accelerating system, and the beam extraction systems.

(2) Guidance

Since the radiation fields around accelerators are complex, often consisting of many different ionizing radiations extending over a broad range of energies, it is not always sufficient to apply the techniques of dosimetry that are known to work well for lower-energy radiations without a clear understanding of the accelerator radiation environment and its interaction with the dosimeter to be used. Dosimeters that work well at low neutron energies often have responses to the high-energy particles present in accelerator environments that make proper interpretation of their measurements complicated. Thus, accelerator facilities should document their dosimetry programs for those radiations and energies not included in the accreditation program for personnel dosimetry covered by DOE 5480.15 by characterizing the radiation fields in terms of particle flux and energy spectra and the dosimeter responses.

b. Radiation Protection Instrumentation

(1) Discussion

Paragraph 9c(5) of DOE 5480.25 and DOE 5480.11, paragraph 9g(3)(b), require monitoring and documenting the ionizing radiation field in and around accelerator facilities. The radiation fields at accelerator facilities generally have a complex structure and may require monitoring instrumentation to. operate in a pulsed radiation field. Varied instrumentation may be required to adequately monitor for personnel protection, beam monitoring, or radiation field assessment.

(2) Guidance
calibrated for the radiation fields encountered.

(b) Calibrations should use written procedures with sufficient detail, and be consistent with ANSI N323-1978.

(c) The radiation protection instruments should be calibrated at least annually (as per ANSI N323-1978, rather than quarterly per ANSI N43.1-1978).

(d) An auditable record of calibration results and quality assurance efforts should be maintained.

c. Control of Induced Radioactivity

(1) Discussion

For many accelerator operations the largest dose equivalents and much of the collective dose equivalent arise from exposure to induced radioactivity during repair, maintenance, and modification activities. These doses come mainly from gamma radiation resulting from activation of solid, often thick, objects by penetrating radiation. As a result, external gamma radiation normally dominates the exposure; beta dose rates are relatively low.

Much high-energy accelerator induced radioactivity is produced by "spallation," in which a high energy particle strikes a target nucleus causing the emission of possibly several nucleons or larger nuclear fragments. These processes result in radionuclides that tend to the neutron deficient side of the periodic chart stability line. Thus a large part of the accelerator induced radioactivity decays by positron emission or electron capture. In electron capture, the radionuclides can only be detected by their photon emission (important examples are Be-7, Mn-54, and Cr-51).

(2) Guidance

(a) Surface Contamination

Some high intensity accelerator facilities can produce significant surface contamination and possible airborne activity, usually due to Be-7 produced by spallation reactions in air or vaporized target materials. Special monitoring techniques may be required to meet the control criteria in the DOE RCM, DOE 5480.11 and DOE 5400.5.

(b) Activated Material

Much accelerator construction material becomes slightly radioactive, but does not become highly radioactive even after years of service. Due to the penetrating nature of high energy radiation, the radioactivity is usually distributed throughout a sizeable volume of material. If the dimensions of the component are large with respect to the photon mean free path and the radionuclides are more or less uniformly distributed throughout the irradiated material, an accurate estimation of activity concentration can be made by measuring surface dose rates.

For-accelerator produced radioactivity in ordinary materials of construction (i.e. aluminum, copper, iron, concrete, earth, etc.), material that has an activity level of less than 0.4 Bq/g (about 10 pCi/g) is not important radiologically and is considered uncontaminated in Great Britain (G.B.S.I. 1986). However, as required in DOE 5400.5, Chapter II, 5c(6), such materials may be released only when using EH-1 approved criteria and survey techniques.

d. <u>Radiation Dose Limits to the Public</u>

(1) Discussion

The radiation dose limit via the air pathway to the public from DOE operations, including accelerators, listed in DOE 5400.5 is the EPA regulation (40 CFR Part 61, Subpart H) limit on dose to the public of 10 mrem/year from radioactive gas released to the environment. Since the EPA limit is small compared to typical background exposure (approximately 350 mrem/year at most locations), great care will be required in monitoring to differentiate the incremental dose from radionuclides released to the air.

(2) Guidance

(a) The document "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance" (DOE/EH-0173T) of January 1991 contains the requirements for monitoring releases and assessing-dose to the public. Table 3-1 of that documents shows that emission points causing doses above 0.1 mrem/yr require monitoring.

(b) To keep air releases ALARA, the contractor should consider minimizing the air path that particle beams traverse and maintaining dead-air volumes where beams must pass through air. By keeping air flow slow and the paths long before venting to the atmosphere, the typically short-lived radioactive nuclides can decay.

e. Health Physics Program Content

(1) Discussion

DOE 5480.4 lists ANSI N43.1-1978, "Radiological Safety in the Design and Operation of Particle Accelerators" as a mandatory radiation protection standard. While ANSI Committee N43 recommended withdrawal of this standard, it defines minimum requirements "that DOE and its contractors must comply with to the extent they apply to the activities being conducted."

(2) Guidance

(a) Even though permissible radiation levels have changed considerably, and data in ANSI N43.1-1978 applies principally to accelerators with primary energies less than 100 MeV, the standard contains applicable and valid concepts which are to be considered in establishing the operational health physics program for an accelerator facility.

(b) SLAC-321 could be used in establishing elements of a health physics program unique to an accelerator facility.

(c) Radiological control programs need to be established to implement the DOE Radiological Control Manual (DOE/EH-0256T).

2. MAGNETIC FIELDS AND NON-IONIZING RADIATION

a. Discussion,

High magnetic fields are present at many particle accelerate r facilities and their equipment. While the health risks from magnetic fields are not well understood, there is a particular hazard to persons with pacemakers. High magnetic fields may also present safety hazards from the forces they exert on ferromagnetic materials such as tools. Perceptible or adverse effects have been produced at higher flux densities on persons with other implanted ferromagnetic medical devices (suture staples, aneurism clips, prostheses, etc.).

Radiofrequency/microwave radiation is present at most accelerator facilities. Typical primary sources are klystrons, magnetrons, and backward wave oscillators. For most microwave installations, high system performance and safety are mutually reinforcing goals; radiation leaks which expose people also adversely affect the performance of the system.

Both magnetic fields and radiofrequency fields can interfere with some radiological survey instruments.

b. Guidance

(1) The American Conference of Government Industrial Hygienists (ACGIH) specifies guidelines for personnel protection in the form of Threshold Limit Values (TLVs). Use of these guidelines, in their most current form for static magnetic fields and radiofrequency/microwave radiation, are mandatory for DOE-funded operations in accordance with DOE 5480.4.

(2) To avoid exposure of persons to unacceptable levels of RF energy, engineered control measures, such as shielding, prevention of wave guide leakage, enclosures, interlocks preventing accidental energizing of circuits, and dummy load terminations, should be given first consideration over any use of personal protective equipment. Where exposure in excess of the limits is possible, RF leakage tests should be conducted when the system is first operated and after modifications which might result in changes to the leakage. Area RF monitors are appropriate when RF energy can be expected in occupied areas.

PART II. G

OCCURRENCE REPORTING

I. DISCUSSION

DOE 5000.3B requires that certain events and conditions be categorized and reported, and that there be a system for documenting them,. identifying their causes, specifying appropriate corrective actions, and ensuring that such actions are taken.

The categorization standards of DOE 5000.3B, Attachment 1, reflect the DOE-desired degree of significance in the three specified categories of reportable occurrences: emergency, unusual occurrence, and off-normal. Accelerator facilities are having reasonable success in adapting the occurrence reporting guidance in that Order to their specific situations, so comprehensive guidance is not provided-in what follows.

2. GUIDANCE

a. Implicit in the notion of an Accelerator Safety Envelope (see Part I.D.) is that variations in operating conditions may be permitted if and only if they do not exceed the bounds imposed by the Accelerator Safety Envelope. A variation beyond the boundaries of the Accelerator Safety Envelope should be reported as defined by DOE 5000.3B. Variation of an operating parameter outside the Operations Envelope but within the Accelerator Safety Envelope does not in and of itself require reporting under DOE 5000.3B, even when it results in remedial actions being taken.

b. The definition of Class B Equipment in DOE 5000.3B (Attachment 1, page 2, item 2) should be extended to include passive or active devices, systems, or structures which protect persons from major consequences. Specific examples would be:

   <u>Personnel protection systems</u> controlling access to enclosures in which very high radiation levels can exist, including the beam interlock safety system required by paragraph 9a of DOE 5480.25.

   <u>Radiation shielding boundary enclosing</u> an area in which very high radiation levels can exist.

   <u>Beam containment systems</u> which ensure that high intensity particle beams do not escape from the intended channel or dump area. This may include dumps with burn through detectors, beam power measuring devices, and associated interlocks and administrative procedures for verification.

Radiation monitoring systems which are interlocked with the accelerator, and required as a back-up to detect the failure of one of the above systems.

Asphyxiation protection systems including oxygen deprivation warning devices, cryogenic hazard safety systems to protect against asphyxiation from cryogenic fluids in enclosures, emergency escape breathing apparatus, escape routes, etc.

Interlocks to protect against exposed electrical hazards.

REFERENCES

a. ANSI N43.1-1978, RADIOLOGICAL SAFETY IN THE DESIGN AND OPERATIO N OF PARTICLE ACCELERATORS, of 7-25-78, which provides a standard for particle accelerators for non-medical applications, principally with primary energies less than 100 MeV.

b. ANSI N323-1978, RADIATION PROTECTION INSTRUMENTATION TEST AND CALIBRATION, of 9-13-77, by The Institute of Electrical and Electronics Engineers, Inc. of New York, which establishes calibration methods for portable radiation protection instruments used for detection and measurement of levels of ionizing radiation fields or levels of radioactive surface contamination, is a mandatory occupational health protection standard imposed by DOE 5480.4.

C. ANSI N543-1974, "General Safety Standard for Installations Using NonMedical X-Ray and Sealed Gamma-Ray Sources, Energies Up to 10 MeV," which establishes requirements for the design and operation of common types of installations that use gamma and X radiation for non-medical purposes; methods for achieving adequate radiation protection are described, including structural details, surveys and inspections, and operating procedures.

d. DOE 4700.1, PROJECT MANAGEMENT SYSTEM, of 3-6-87, which sets forth the principles and requirements governing the development, approval, and execution of DOE's outlay program acquisitions.

e. DOE 5000.3B, OCCURRENCE REPORTING AND PROCESSING OF OPERATIONS INFORMATION, of 1-19-93, which establishes a system for reporting of operations information related to DOE-owned or operated facilities and processing of that information to provide for appropriate corrective action.

f. DOE 5400.5, RAD,IATION PROTECTION OF THE PUBLIC AND THE ENVIRONMENT, of 65-90, which establishes standards and requirements for operations of the Department of Energy (DOE) and DOE contractors with respect to protection of members of the public and the environment against undue risk from radiation.

g. DOE 5480.4, ENVIRONMENTAL PROTECTION, SAFETY, AND HEALTH PROTECTION STANDARDS, of 9-20-91, which specifies and provides requirements for the application of the mandatory environmental protection, safety, and health (ES&H) standards applicable to all Department of Energy (DOE) and DOE contractor operations; to provide a listing of reference ES&H standards; and to identify the sources of the mandatory and reference ES&H standards.

h. DOE 5480.5, SAFETY OF NUCLEAR FACILITIES, of 9-23-86,'which establishes -DOE's nonreactor nuclear facility safety program.

i. DOE 5480.7A, FIRE PROTECTION, of 2-17-93, which establishes requirements for an "improved risk" level of fire protection sufficient to. attain Department of Energy objectives.

j. DOE 5480.11, RADIATION PROTECTION FOR OCCUPATIONAL WORKERS, of 6/17/92 which establishes DOE's radiation protection program requirements.

k. DOE 5480.15, DEPARTMENT OF ENERGY LABORATORY ACCREDITATION PROGRAM FOR PERSONNEL DOSIMETRY, of 12-14-87, which defines requirements for participation in the DOE Laboratory Accreditation Program.

1. DOE 5480.19, CONDUCT OF OPERATIONS REQUIREMENTS FOR DOE FACILITIES, of 5-18-92, which provides requirements and guidelines for Departmental elements to use in developing directives plans, and/or procedures relating to the conduct of operations at DOE facilities.

M. DOE 5480.23, NUCLEAR SAFETY ANALYSIS REPORTS, of 4-10-92, which establishes safety analysis requirements for nuclear facilities.

n. DOE 5480.25, SAFETY OF ACCELERATOR FACILITIES, of 11-3-92, which .establishes safety program requirements specific to accelerator facilities.

0. DOE 5481.1B, SAFETY ANALYSIS AND REVIEW SYSTEM, of 5-19-87, which establishes uniform requirements for the preparation and review of safety analyses for non-nuclear operations.

p. DOE/EH-0173T, ENVIRONMENTAL REGULATORY GUIDE FOR RADIOLOGICAL EFFLUENT MONITORING AND ENVIRONMENTAL SURVEILLANCE, of January 1991, which establishes elements of a radiological effluent monitoring and environmental surveillance program considered acceptable to the Department of Energy.

q. DOE/EH-0256T, DOE RADIOLOGICAL CONTROL MANUAL (RADCON MANUAL), of June 1992, provides DOE's positions and views on the best courses of action currently available in the conduct of radiological control activities.

r. DOE-STD-1027-92, HAZARD CATEGORIZATION AND ACCIDENT ANALYSIS TECHNIQUES FOR COMPLIANCE WITH DOE 5480.23, NUCLEAR SAFETY ANALYSIS REPORTS, of December 1992, which, among other matters, provides a uniform methodology for hazard categorization, and guidance on the applicability of DOE 5480.23.

S. Great Britain Statutory Instruments 1986, No. 1002, RADIOACTIVE SUBSTANCE (SUBSTANCES OF LOW ACTIVITY) EXEMPTION ORDER 1986, which declares an exemption for solid radioactive material which is substantially insoluble in water with activity less than 0.4 Bq/g.

t. NFPA 101, CODE FOR SAFETY TO LIFE FROM FIRE IN BUILDINGS AND STRUCTURES, 1988. (LIFE SAFETY CODE)

u. 'SLAC-327, HEALTH PHYSICS MANUAL OF GOOD PRACTICES FOR ACCELERATOR FACILITIES, of April 1988, which presents guidance t6 be used to develop and conduct radiation protection pro-grams at DOE accelerator facilities.

V. Title 29 CFR 1910, OCCUPATIONAL SAFETY AND HEALTH STANDARDS. Section 119, Process Safety Management of Highly Hazardous Chemicals, addresses process hazard analysis, guidelines for process safety management, and other relevant items.

W. Title 40 CFR 61, NATIONAL EMISSIONS STANDARDS FOR HAZARDOUS AIR POLLUTANTS; RADIONUCLIDES, of 12-15-89, which announces the Administrator's final decisions on National Emissions Standards for Hazardous Air Pollutants under section 112 of the Clean Air Act.

Appendix A
Guidance Relationship to Requirements of DOE 5480.25

	5480.25 Requirmnt	Guidance Reference	Guidance Page	5480.25 Requirmnt	
	7.a.(1)	Intro.	1	9.c.(3)	
	7.a.(2)	I.A.2.a.	8	9.c.(4)	II.F.I
.a.		57			
	7.a.(3)	I.D.1.	21		II.F.l
.e.		60			
		I.E.2.a.	25	9.c.(5)	ILF.
Lb.(1)	58				
		I.E.2.c.	27	g.c.(6)	I.A.2
.g.		10			
	7.a.(4)			9.d.	
I.A.7					
	7.a.(5)	I.E.2.a.	25		I.A.3
.a.		11			
	7.a.(6)			9.e.	I.E.2
.a.		25			
	7.a.(7)			9.f.	ii.A.
2.b..		41			
	7.b.(I)			9.g.	
II.E.		51			
	7.b.(2)	I.E.2.a.	25	9.h.	
	7.b.(3)	I.D.I.	*21*	9J.	II.A.
2.f.		42			
		I.E.2.c.	27		
II.C.		47			
	7.b.(4)			9.j.	
	7.b.(5)	I.E.2.c.	27	10.	
I.B.		13			
	7.b.(6)	I.D.1	21		I.C.2
.		17			
	7.b.(7)	Intro., Tbl.I	3		
I.D.I.		21			
	7.b.(8)				II.C.
2.		47			
	7.b.(9)			10.a.	I.A.2
.a.(2)	8				
	7.b.(10)				
I B.1.		13			
	7.c.				I.B
.2		15			
	7.d.				I.C.1
.		17			
	7.e.				I.C.2
.,Ch.4	19				
	8.a.			10.b.	
		I.A.	7	10.c.	I.E.2
.a.		25			
		I.A.I.	7	10.d.	I.C.2
.,Ch.5	20				
		I.A.3.a.	11	10.e.	I.E.2

.a.		25			
	8.c.	I.D.3.e.	24	10.f.	I.B.1
.		13			
		I.E.2.a.	25		I.B.2
.a.		15			
		I.E.2.c.	25.		I.C.2
.,Ch.3(f)		18			
	B.d.	I.C.2.,Ch 5	19	10.g.	
I.B.1		13			
		I.D.	*21*		II.B.
2.d.		45			
		II.A.2.e.	42		II.C.
2.a.		47			
		II.G.2.a.	63		II.C.
2.d.		47			
	8.e.	II.B.2.d.	45	10.h.	II.B.
2.d.		45			
	B.f.	II.E.	51	10J.	I.B.2
.e.		16			
	8.g.			10.j.	
I.B., Fig. 1		14			
	8.h.			11.	
I.E.		25			
	9.a.(I)	II.G.2.b.	63	11.a.	
I.B.1		13			
	9.a.(2)	I.F.2.f.(2)	34	11.a.(1)	
I.B.1		13			
	9.b.	I.A.2.d.	9		I.D.2
.c.		22			
		H.D.'	49		I.E.2
.a.		25			
	9.c.(I)	I.F.I.	29	11.a.(2)	I.E.2
.b.		27			
		II.F.2.b.	61		I.E.2
.c.		27			
	9.c.(2)	H.D.2.a.	49		
		.E.2.b.(3)	53		
		H.E.2.g.	55		

Guidance Relationship to Requirements of DOE 5480-25

5480.25 Requirement	Guidance Reference	Guidance Page
11.b.	I.B.I.	13
11.b.(1)	I.B.I.	13
11.b.(2)	I.D.2.c.	22
	I.E.2.a.	25
11.b.(3)	I.E.2.b.	27
11.c	I.E.2.c.	27
I1.d	I.E.2.b.	27
11.e	I.B.2.a.	15
Il.f.	I.E.2.c.	27
11.g.	I.E.2.c.	27
11.h.	I.A.1	7
	I.A.2.d.	9
	I.E.1.	25
11.i.	I.A.I.	7
	I.A.2.d.	9
	I.E.2.a.	25
	II.C.2.e.	48
12.	II.E.	51
12.a.(1)	II.E.2.b.	53
12.a.(2)	II.E.2.a.(2)&(4)	51
12.a.(3)	II.E.2.a.(3)	51
12.a.(4)	II.E.2.a.(5)-(7)	52
12.a.(5)		
12.a.(6)	II.E.2.a.(7)	52
12.a.(7)		
12.b.(1)	II.E.2.c.	53
	II.E.2.d.	54
12.b.(2)		
12.b.(3)		
12.c.	II.E.2 ' e.	55
12.d.	II.E.2.fi	55
13.	II.B.	45
13.a.(1)		
13.a.(2)	II.B.2.e.	46
13.a.(3)		
13.a.(4)	II.B.2.b.	45'
13.a.(5)	II.B.2.a.,b.,& d.	45
13.a.(6)	II.B.2.a.	45
	II.B.2.d.	45
13.a.(7)		
13.b.	II.B.2.f.	46
	II.B.2.g.	46
13.c.		
14.	Addressed by separate document	

GLOSSARY

a. Accelerator is a device employing electrostatic or electromagnetic fields to impart kinetic energy to molecular, atomic or sub-atomic particles ' and, for purposes of this Order, capable of creating a radiological area.

b. Accelerator Facility is the accelerator and associated plant and equipment utilizing, or supporting the production of, accelerated particle beams to which access is controlled to protect the safety and health of persons. It includes experimental enclosures and experimental apparatus utilizing the accelerator, regardless of where that apparatus may have been designed, fabricated, or constructed.

C. Accelerator Readiness Review is a structured method for verifying that hardware, people, and procedures associated with Commissioning or Routine Operation are ready to permit the activity to be undertaken safely.

d. Accelerator Safety Envelope is a set of physical and administrative conditions that define the bounding conditions for safe operation at an accelerator facility.

e. Approve is to confirm that a proposed contractor activity has acceptable safety and health implications.

f. Authorize is to give a right to undertake an activity; as applied to contractor activities, this action is reserved for the DOE Contracting Officer.

g. Commissioning is the process of testing an accelerator facility, or portion thereof, to establish the performance characteristics. It starts with the first introduction of a particle beam into the system.

h. Critical Devices are specific accelerator or beam line components that are used to ensure that the accelerator beam is either inhibited or cannot be steered into areas where people are present.

i. Experimenters are all persons directly involved in experimental efforts at the accelerator facility utilizing the accelerator or its beams, including visiting scientists, students and others who may not be employees of the operating contractor.

j. Hazard is a source of danger (i.e., material, energy source, or operation) with the potential to cause illness, injury, or death to people or damage to a facility or to the environment (without regard for the likelihood of a harmful event occurring or of consequence mitigation). In DOE 5481.1B (September 23, 1986), hazards are classified by types and magnitudes as Routinely Accepted, Low, Moderate, and High.

k. Maintenance Personnel means not only those in the crafts generally associated with maintenance activities, but also accelerator operations -staff and experimenters to the extent that they undertake to repair, maintain, or improve safety-related equipment.

l. Program Secretarial Officer (PSO) is a senior outlay program official and includes: the Deputy Secretary for Energy Programs; and the Under Secretaries for Weapons/Waste Cleanup Programs and for Science and Technology Programs.

M. Radiological Area means any area requiring posting as a radiation area or an airborne radioactivity area as these terms are defined by the Radiological Control Manual implementing the radiological control requirements of DOE 5480.11.

n. Risk is a quantitative or qualitative expression of possible harm which considers both the probability that a hazard will cause harm and the amount of harm.

0. Routine Operation of an accelerator commences at that point where DOE authorization has been granted either (1) because the Commissioning effort is sufficiently complete to provide confidence that the risks are both understood and acceptable and the operation has appropriate safety bounds, or (2) to permit the re-introduction of a particle beam after being directed to cease operation by DOE because of an environmental, safety, or health concern.

P. Safety Analysis is a documented process to systematically identify the hazards of a given operation; describe and analyze the adequacy of measures taken to eliminate, control, or mitigate the hazards and risks of normal operation; and identify and analyze potential accidents and their associated risks.

q. Safety Assessment Document is the document containing the results of a safety analysis for an accelerator facility pertinent to understanding the risks of the proposed undertaking.

r. An Unreviewed Safety Issue exists if a proposed change, modification or experiment will:

(1) Significantly increase the probability of occurrence (through reduction in the margin of safety or otherwise) or the consequences of an accident or malfunction of equipment important to safety from that evaluated previously by safety analysis; or
(2) Introduce an accident or malfunction of a different type than any evaluated previously by safety analysis which could result in significant safety consequences.

INDEX

INDEX